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WaterWiser®

The Water Efficiency Clearinghouse

1997 Residential Water Use Information Summary

by

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for

WaterWiser - The Water Efficiency Clearinghouse

Text, Figures and Tables for Web Pages

Water Use "Outside" the Home

"Outside" water use for the typical home is extremely variable. A study of five cities in the western half of the United States where end use data logging has been done shows outside use averaging 65% of total residential use during the growing season (low = 57%, high = 77%). Outside use in eastern cities with summer rainfall would be less. Outside use can be for landscape (and garden) purposes or for non-landscape purposes, such as washing a car, etc., but landscape uses by far make up the lion's share.

Some of the most important variables that affect landscape water use are: the amount and frequency of rainfall during the growing season, length of growing season, area of landscape/garden, type of plant material - particularly the amount, extent and root depth of turfgrass, consumptive use requirements of the plant material (which is a function of evapotranspiration) , soil type, slope, amount of shade, wind, method used to apply water (hose and sprinkler, in-ground sprinkler system, drip, bubbler, etc.), how efficiently application method(s) are managed (frequent adjustment of time clocks to "track" evapotranspiration, rain shut-off devices, etc.), and general horticulture (particularly turfgrass horticulture) and maintenance practices. Since the above factors vary so widely from site to site it is not practical to accurately quantify typical single family detached home use for different regions of the country. Rather we have chosen to present a "rule of thumb" method for you to roughly estimate the annual water requirement for your landscape. To use this method, you only have to make a few measurements in your yard and follow these simple steps:

1. On a piece of paper, make a rough sketch of your landscape dividing it into the applicable categories shown in Table 3. Then measure these areas and determine the square footage (you do not have to measure precisely as at best the result of this method is an approximation). Group the results into the same four categories shown in Table 3. That's all the measuring you have to do.

2. For each landscape group determined in Step 1, use the following "rule of thumb" formula to determine the annual applied water requirement (AWR) in gallons per year for each basic type of landscape:

$$AWR = S \times A \times V \times 0.623$$

where:

S = a factor you lookup in Table 3 which corresponds to one of your basic landscape types.
A = the combined area (square feet) you measured for that landscape type.
V = a value you lookup in Table 4. (This value represents an approximation of the applied water requirement for efficiently irrigated cool season grass in your area.)
0.623 = a constant that converts everything to gallons per year.

3. Sum up the resulting AWRs for each landscape type. This total then is a rough approximation of the annual AWR for your landscape, i.e. the amount of water you need to apply as irrigation water taking into account evapotranspiration rates in your area and the amount of rainfall available in a normal year. For more information, read the Section entitled: More Accurate Method of Estimating Landscape Water Requirement.

✍ *The information on this web page was compiled by John Olaf Nelson Water Resources Management* applied and how well the system is scheduled to deliver water to the plant root zone in a timely manner.) A well managed sprinkler irrigation system can achieve an IE of about 65%, but lower values for single family homes are much more common. For a drip system, IE of 90% can be achieved as water can be applied right where the roots of the plant need it.

Appropriate values to use for ET_0, K_c, ER and IE should be obtained from local sources such as the nearest office of the U.S. Department of Agriculture's National Resource Conservation Service, an appropriate state agency, a nearby university, your local water utility, nurseries and companies providing products and services, or one of the associations serving the landscape industry or professionals such as landscape architects.

Monthly, weekly and even daily values for AWR can be calculated using this same approach since ET_0, K_c, and ER vary daily. There are better ways to determine the actual amount of water you need to apply in any given week however. Check with the references noted above.

For an example showing how rainfall, ET_0 and AWR vary from month to month, see Figure 3. This example is for a western city in a semi-arid area. AWR is a net value and takes into account all of the factors noted in the equation above. An irrigation efficiency of 50% was used for this example. That's about the best you can expect for home irrigation. Note the AWR goes through a steep incline in late spring, peaks in July and drops off rapidly starting in late summer. The potential for saving water by adjusting irrigation system applications is obvious. While this curve is typical for most areas where supplemental water is required for irrigation, one main difference from the east to the west is that substantial rain falls during the growing season in the east. The AWR curve would be less "humpy" and be more irregular in the east. Where in-ground sprinkler systems are used, adjusting settings to ET_0 demands is never-the-less a good conservation practice for the east.

as uniformly as possible and invest in good quality sprinkler heads that provide the lowest possible precipitation rate and keep heads in good repair.

If you have an in-ground sprinkler system and it is controlled by a time clock (controller) change the valve run-times and number of cycles of irrigation as evapotranspiration changes throughout the irrigation season. Generally doing this three or four times a season will do the trick in most areas. (Ask your local water utility where you can get information on evapotranspiration and advice on irrigation scheduling.) Also, in areas with appreciable rain during the growing season, install a good quality rain shut-off device to eliminate unneeded irrigations.

Tip for subdivision lots: If your turfgrass parcels are relatively modest in area (say 20 feet x 30 feet) and slope to the street (many subdivision lots have this kind of configuration), realize that your irrigation method (whatever method you use) will likely start to produce runoff to the gutter in 10 to 15 minutes so shut off the water when that occurs, let the water percolate in for about an hour, then give it another dose of 10 minutes. Even in very dry climates at the peak of the summer season, three cycles like this will generally be enough. This type of cycle or syringe irrigation, if done properly, will avoid wasteful runoff while still accomplishing a deep irrigation and thus promote deep rooting. If you have this type of irrigation problem and use an in-ground system, it would be well worth your while to invest in an irrigation clock that can provide this type of cycle irrigation capability.

Shrubs and trees: If shrubs and trees require supplemental irrigation in your climate, you will find a drip system is a very handy way to apply the right amount of water but check it out regularly by feeling around the base of plants after a scheduled irrigation to be sure emitters are operating properly. If this seems unappealing or too time consuming, buy a moisture tester probe (cost about $8) at your local hardware store. Insert the probe and merely check to see if you get a needle swing and you are done. To control moisture around plants, mulching is also an excellent water conservation (and weeding labor) saving practice.

Leak control: Leaks can be insidious and costly. An easy way to check the integrity of your entire water system is to check to see if your meter is registering any use during a period when no water is being used. Simply take a reading (the last two digits or dials on the meter is all you have to read), wait about 20 or 30 minutes (the longer the better because certain types of common leaks have a cycle), then take another. If usage occurred, check the flapper valve and overflow level in all toilets first. The odds are high that is where the problem is, if not check all faucets for leaks and then your pipelines. If you do have an in-ground irrigation system, beware that the valves serving the individual sprinkler lines often periodically allow water to pass (we are learning from new research that this is more frequent than previously suspected). Invest in good quality irrigation valves or install a master valve in your irrigation line(s) and shut it off during the non-irrigation season.

The information on this web page was compiled by John Olaf Nelson Water Resources Management

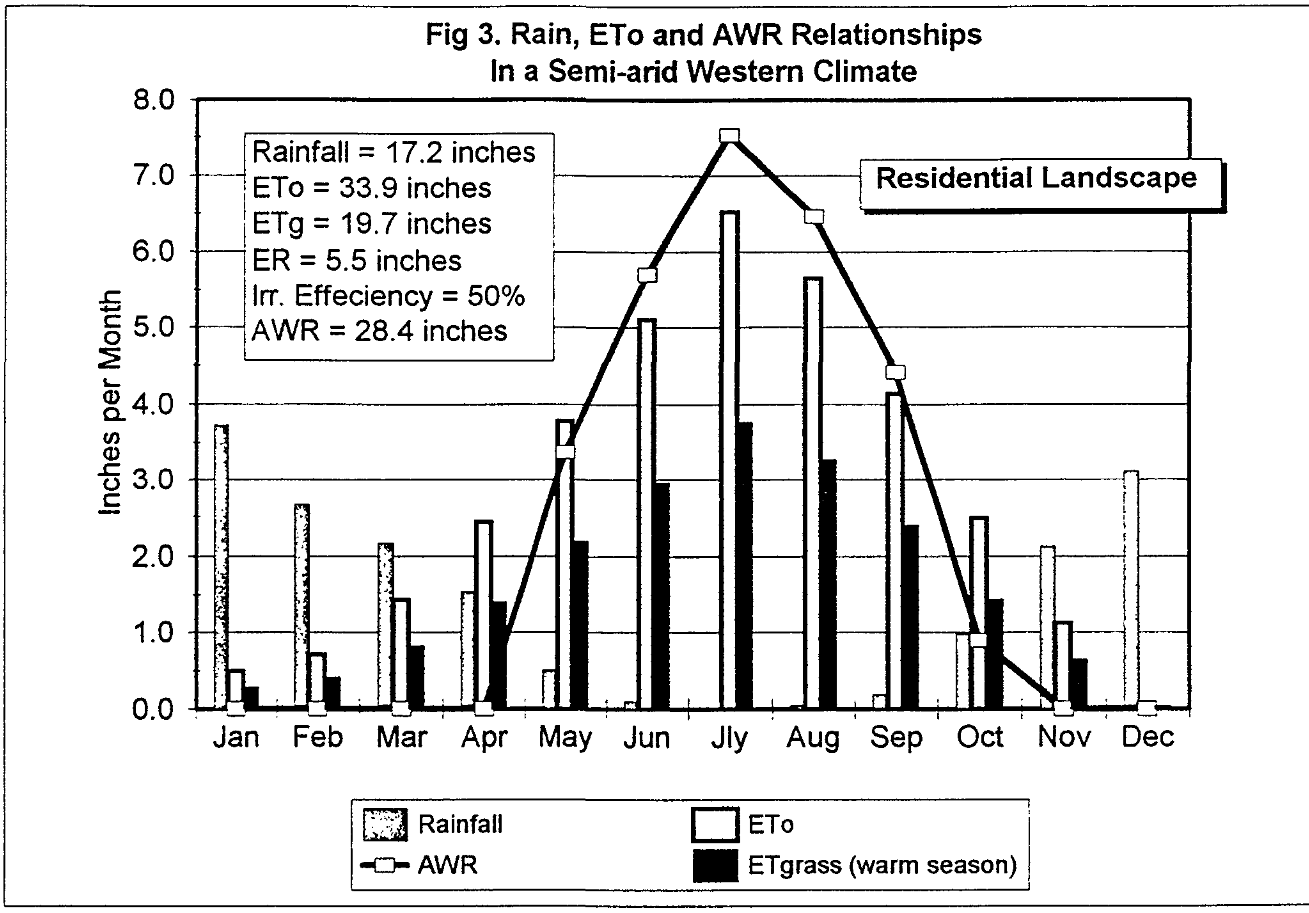
Fig 3. Rain, ETo and AWR Relationships
In a Semi-arid Western Climate
Rainfall = 17.2 inches
ETo = 33.9 inches
ETg = 19.7 inches
ER = 5.5 inches
Irr. Effeciency = 50%
AWR = 28.4 inches
Residential Landscape
Inches per Month
8.0
7.0
6.0
5.0
4.0
3.0
2.0
1.0
0.0
Jan
Feb
Mar
Apr
May
Jun
Jly
Aug
Sep
Oct
Nov
Dec
Rainfall
ETo
AWR
ETgrass (warm season)

Table 2

Use Rate and Percapita Savings of Fixture Measures, gcd

Fixture Measure	Use Rate	Savings, gcd
Low flush toilets	1.6 gpf	8.0
Horizontal axis clothes washers	(varies)	4.5
Low flow showerheads	2.5 gpm	2.2
Faucet aerators *	2.2 gpm	0.3
Leak repair	(varies)	5.1
Total (if all measures installed)		19.9

* Installed on kithchen sink and bathroom faucets

Table 4
Lookup Table for Value "V" *
(V has the valure of inches per year and is based on a normal rainfall year)

State	Sector or Drainage (major city)	V
Alabama	Praire (Montgomery)	15.6
	Gulf (Mobile)	10.4
Arizona	Northeast (Flagstaff)	31.2
	South Central (Phoenix)	76.7
	Southeast (Tucson)	71.5
Arkansas	Central (Little Rock)	19.5
California	North Coast Drainage (Eureka)	27.3
	Sacramento Drainage (Sacramento)	39.0
	Central Coast Drainage (San Francisco)	27.3
	South Coast Drainage (Los Angeles)	62.4
Colorado	Platte Drainage Basin (Denver)	28.6
Connecticut	Central Coastal (Hartford)	16.9
Delaware	Northern (Wilmington)	20.8
Florida	North (Jacksonville)	36.4
	South Central (Tampa)	36.4
	Lower East Coast (Ft. Lauderdale)	33.8
Georgia	(entire state)	29.9
Idaho	Southwestern Valleys (Boise)	35.1
Ilinois	Northeast (Chicago)	19.5
	West Southwest (Springfield)	22.1
Indiana	Central (Indianapolis)	20.8
Iowa	Central (Des Moines)	20.8
Kansas	Northeast (Kansas City)	23.4
	South Central (Wichita)	18.2
Kentucky	Central (Louisville)	23.4
Louisana	Southeast (New Orleans)	20.8
Maine	Coastal(Portland)	11.7
Maryland	Northern Central (Baltimore)	20.8
Massachusetts	Coastal (Boston)	16.9
Michigan	Southeast Lower (Detroit)	14.3
Minnesota	East Central (Minneapolis)	10.4
Mississippi	Coastal (Biloxi)	20.8
	Southwest (Vicksburg)	24.7
Missouri	Northeast Prairie (St. Louis)	23.4
	Northwest Prairie (Kansas City)	19.5
Montana	Western (Missoula)	20.8
Nebraska	East Central (Omaha)	26.0
Nevada	Northwestern (Reno)	36.4
	Extreme Southern (Las,Vegas)	55.9
New Hampshire	Southern(Concord)	14.3
New Jersey	Northern (Newark)	13.0
New Mexico	Northern Mountains (Santa Fe)	31.2
	Central Valley (Albuquerque)	39.0
New York	Coastal (New York)	14.3
	Great Lakes (Buffalo)	13.0
North Carolina	Southern Mountains (Asheville)	14.3
	Central Piedmont (Raleigh)	24.7
North Dakota	South Central (Bismark)	19.5
Ohio	Northeast (Cleveland)	18.2
	Southwest (Dayton)	20.8
Oklahoma	Central (Oklahoma City)	26.0
Oregon	Willamette Valley (Portland)	24.7
Pennsylvania	Southeastern Piedmont (Philadelphia)	13.0
Rhode Island	(entire state)	14.3
South Carolina	Southern (Charleston)	24.7
South Dakota	Southeast (Sioux Falls)	24.7
Tennesee	Western (Memphis)	22.1
Texas	North Central (Dallas)	37.7
	South Central (San Antonio)	49.4
	Upper Coast,,(Houston)	28.6
Utah	North Central (Salt Lake City)	31.2
Vermont	Northeastern (Montpelier)	14.3
Virginia	Eastern Piedmont (Richmond)	13.0
Washington	Puget Sound Lowland (Seattle)	19.5
West Virginia	Southwestern (Charleston)	13.0
Wisconsin	Southeast (Milwaukee)	11.7
Wyoming	Platte Drainage (Cheyenne)	23.4

* "V" is the estimated applied water requirement for cool season grasses. It is based on irrigation requirement for alfalfa reported by US Dept. of Agriculture Soil Conservation Service in a 1976 special study. Values reported in the study were adjusted by the author to reflect differences in irrigation effeciency and differences in evapotranspiration requirements for cool season grasses.

(In following this explanation it will be useful to first note that "number" tables (Table 1, etc.) refer to tables prepared for the web page, "alpha" tables (Table A, etc.) refer to tables containing my calculations or other information compiled to support my findings. The latter are submitted for the WaterWiser advisory committee and for any serious studier that may request this kind of background detail.)

Section A. **How Much Water is Used "Inside" the Typical Single Family Home**

Table A shows values for water conservation devices I relied upon. Basically I choose to use essentially rely only on those studies that actually measured savings directly.

Table B is a detailed list of references cited in Table A.

All other information contained in Figures 1 and 2 and in Tables 1 and 2, not derived from Table A, was obtained from material from the on-going residential end use study (with one exception). Average end uses shown in Table 1 and Figure 1 are based on logging data done twice (2 weeks each time) in 6 cities: Boulder, Denver, Eugene, Seattle, San Diego and Tampa. The exception is (as noted at the bottom of Table 1) that the 64.6 gcd (gallons per capita per day) value used as the "w/o any conservation" is set 5% higher than the actual average found from logging to account for my estimate of existing average across-the-board water savings extant in those cities. I have no verification of what the real amount is (nor do the cities in question) but I know its something. The 5% represents my best judgement on the matter. Remember that our logging sample checks out with +/- 95% confidence to be representative of *all* single family detached residential customers in those six cities.

I would also note that the values in the above tables have changed slightly from the data provided the committee in Atlanta due to the fact that the second logging period data for both San Diego and Tampa were not available at that time. They are now available and hence I updated the figures. The biggest change I have made is to reduce the showerhead savings value to 2.4 gcd (17.7% reduction). This is because I did not include "zero" (no shower days) in the previous calculation. Aquacraft had determined the percentage of "zero" shower days and included it in the paper presented in Atlanta but did not include it in determining showerhead savings. I felt compelled to include this effect in calculating an annualized rate of savings. The calculation adjusting the result contained in Ref. 6 (the End Use Team's Atlanta paper) is shown in Table C. Now one could argue about this since the 12 logging periods are only two weeks long, but they include nearly 600 homes! The bad news is I might be proved a bit conservative on this when all the logging data is in and analysis completed. The good news is that the final data coming out of the end use study will be yield a reliable result. (Incidentally, the reduction in Table 1 shows up as 2.2 gcd because I used the 17.7% figure to calculate it rather than the gcd value.)

Section C. **A More Accurate Method of Estimating Landscape Water Requirement**

Section C describes a more accurate way of determining the annual landscape applied water requirement taking into account reference ET, the crop coefficient, effective rainfall and a combined (hardware efficiency and management efficiency) irrigation efficiency. The method is well described in the AWWA publication "Water Efficient Landscape Guidelines", 1993 that Dick Bennett was instrumental in putting together and I have used it for many years at North Marin Water District to calculated AWR for the District's turfgrass irrigation advisory hotline.

Figure 3 puts it altogether in a picture. I used the potential ET data Toro had for Sacramento, CA for this example.

Section D. **Some Tips on How to Save Water in Your Landscape**

This section contains what I consider the most important information to convey and focus on regards potential savings in the home landscape. In truth turf is where the action is so that is what I focused on. No references here, strictly from my head although you will find much of the same stuff in papers I have written. The claim that in-ground sprinkler systems use 20% to 30% more water is solid and comes from work done at my old utility, North Marin Water District, and is documented in ("Water Saved by Single Family Xeriscapes," AWWA National Conference, New York City, NY, June 1994.). Tony Gregg has done even more documentation on this in his studies in Austin, TX which are written up in several conference proceeding papers.

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Table B, References Noted in Table A

1 A&N Technical Services, Inc., The Conserving Effect of Ultra Low Flush Toilet Rebate Programs, Metropolitan Water Dist. of Southern CA, June 1992
2 A&N Technical Services, Inc., Continuous-Time Error Components Models of Residential Water Demand, MWD of Southern CA, June 1992
3 A&N Technical Services, Inc., Ultra Low Flush Toilet Programs: Evaluation of Program Outcomes and Water Savings, MWD of Southern CA, Nov 1994
4 Stevens Institute of Technology, East Bay Municipal Utility District Water Conservation Study, Oct 1991
5 Stevens Institute of Technology, The Impact of Water Conserving Plumbing Fixtures on Residential Water Use Characteristics: A Case Study in Tampa, FL, Feb 1993
6 DeOreo, Nelson, Mayer and Opitz; North American Residential End-Use Study: Progress Report, June 1997, Conference Proceedings of AWWA
7 DeOreo, Lander and Mayer, Evaluating Conservation Retrofit Savings with Precise End Use Data, Heatherwood, CO, June 1996, AWWA Conf. Proceedings
8 Dietemann, Allan and Hill, Susan, Water and Energy Effeciency Clothes Washers, 1994 AWWA Conf. Proceedings
9 Hill, Pope, Winch; Thelma: Assessing the Market Transformation Potential for Effecient Clothes Washers in the Residential Sector, Conserv96
10 Brown and Caldwell, Residential Water Conservation Projects, Summary Report, U.S. Dept of Housing & Urban Development, Water Resources Bull., June 1994
11 Whitcomb, John, Water Use Reduction from Retrofitting Indoor Water Fixtures, Dec 1990
12 Specifications and literature obtained from Maytag and Frigidaire, June 1997
13 Maddaus, AWWA Water Conservation Report, 1987
14 John Olaf Nelson's estimate

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Table D, Basis for "V", the Applied Water Requirement for Cool Season Grass

State	Sector or Drainage (major city)	Irr Req't for Alfalfa (National Assess.(1)) ac-ft/ac	inches	Irr Req't (AWR) for for Cool Season* inches
Alabama	Praire (Montgomery)	1.2	14.4	15.6
	Gulf (Mobile)	0.8	9.6	10.4
Arizona	Northeast (Flagstaff)	2.4	28.8	31.2
	South Central (Phoenix)	5.9	70.8	76.7
	Southeast (Tucson)	5.5	66.0	71.5
Arkansas	Central (Little Rock)	1.5	18.0	19.5
California	North Coast Drainage (Eureka)	2.1	25.2	27.3
	Sacramento Drainage (Sacramento)	3.0	36.0	39.0
	Central Coast Drainage (San Francisco)	2.1	25.2	27.3
	South Coast Drainage (Los Angeles)	4.8	57.6	62.4
Colorado	Platte Drainage Basin (Denver)	2.2	26.4	28.6
Connecticu	Central Coastal (Hartford)	1.3	15.6	16.9
Delaware	Northern (Wilmington)	1.6	19.2	20.8
Florida	North (Jacksonville)	2.8	33.6	36.4
	South Central (Tampa)	2.8	33.6	36.4
	Lower East Coast (Ft. Lauderdale)	2.6	31.2	33.8
Georgia	(entire state)	2.3	27.6	29.9
Idaho	Southwestern Valleys (Boise)	2.7	32.4	35.1
llinois	Northeast (Chicago)	1.5	18.0	19.5
	West Southwest (Springfield)	1.7	20.4	22.1
Indiana	Central (Indianapolis)	1.6	19.2	20.8
Iowa	Central (Des Moines)	1.6	19.2	20.8
Kansas	Northeast (Kansas City)	1.8	21.6	23.4
	South Central (Wichita)	1.4	16.8	18.2
Kentucky	Central (Louisville)	1.8	21.6	23.4
Louisana	Southeast (New Orleans)	1.6	19.2	20.8
Maine	Coastal(Portland)	0.9	10.8	11.7
Maryland	Northern Central (Baltimore)	1.6	19.2	20.8
Massachu	Coastal (Boston)	1.3	15.6	16.9
Michigan	Southeast Lower (Detroit)	1.1	13.2	14.3
Minnesota	East Central (Minneapolis)	0.8	9.6	10.4
Mississipp	Coastal (Biloxi)	1.6	19.2	20.8
	Southwest (Vicksburg)	1.9	22.8	24.7
Missouri	Northeast Prairie (St. Louis)	1.8	21.6	23.4
	Northwest Prairie (Kansas City)	1.5	18.0	19.5
Montana	Western (Missoula)	1.6	19.2	20.8
Nebraska	East Central (Omaha)	2.0	24.0	26.0
Nevada	Northwestern (Reno)	2.8	33.6	36.4
	Extreme Southern (Las,Vegas)	4.3	51.6	55.9
New Hamp	Southern(Concord)	1.1	13.2	14.3
New Jerse	Northern (Newark)	1.0	12.0	13.0
New Mexic	Northern Mountains (Santa Fe)	2.4	28.8	31.2
	Central Valley (Albuquerque)	3.0	36.0	39.0
New York	Coastal (New York)	1.1	13.2	14.3
	Great Lakes (Buffalo)	1.0	12.0	13.0
North Carc	Southern Mountains (Asheville)	1.1	13.2	14.3
	Central Piedmont (Raleigh)	1.9	22.8	24.7
North Dak	South Central (Bismark)	1.5	18.0	19.5
Ohio	Northeast (Cleveland)	1.4	16.8	18.2
	Southwest (Dayton)	1.6	19.2	20.8
Oklahoma	Central (Oklahoma City)	2.0	24.0	26.0
Oregon	Willamette Valley (Portland)	1.9	22.8	24.7
Pennsylva	Southeastern Piedmont (Philadelphia)	1.0	12.0	13.0
Rhode Isla	(entire state)	1.1	13.2	14.3
South Car	Southern (Charleston)	1.9	22.8	24.7
South Dak	Southeast (Sioux Falls)	1.9	22.8	24.7
Tennesee	Western (Memphis)	1.7	20.4	22.1
Texas	North Central (Dallas)	2.9	34.8	37.7
	South Central (San Antonio)	3.8	45.6	49.4
	Upper Coast,,(Houston)	2.2	26.4	28.6
Utah	North Central (Salt Lake City)	2.4	28.8	31.2
Vermont	Northeastern (Montpelier)	1.1	13.2	14.3
Virginia	Eastern Piedmont (Richmond)	1.0	12.0	13.0
Washingtc	Puget Sound Lowland (Seattle)	1.5	18.0	19.5
West Virgi	Southwestern (Charleston)	1.0	12.0	13.0
Wisconsin	Southeast (Milwaukee)	0.9	10.8	11.7
Wyoming	Platte Drainage (Cheyenne)	1.8	21.6	23.4

Table E, Showing How factor "S" was derived

	Kc	IE (4)	Kc x IE	S (6)
Cool season grasses (bluegrass, rye, tall fescue)	0.80 (1)	0.50 (4)	1.60	1.00
Warm season grasses (Bermuda, Zoysia)	0.58 (2)	0.50 (4)	1.17	0.73 *
Groundcovers	0.60 (3)	0.81 (5)	0.74	0.46
Shrubs and trees	0.30 (3)	0.90 (3)	0.33	0.21

Notes:

(1) Calif DWR Office of Water Conservation, Art Carvajal, 8/3/97

(2) UC Cooperative Extension Service, Leaflet 21499

	Daily ET, in	Ratio	Annual Kc
Cool season	0.390	1.00	0.80 (1)
Warm season	0.285	0.73 *	0.58 calc'd

(3) AWWA Water Effecient Landscape

(4) Experience of author and recommendation of Gary Kah of Gary Kah and Associates

(5) Value from Ref.(3) increased by 25% to reflect effeciency added by extensive rooting systems

(6) This column sets value for cool season grasses to 1.00 and references all other values in proportion thei

Definitions: Kc = crop coefecient, IE = overall irrigation effeciency

* Note the fact that the two asterisked values are the same (at least to the 100's place) is coincidental.